PATENT SPECIFICATION (11) 1 277 086

1 277 086

NO DRAWINGS

(21) Application No. 25452/69 (22) Filed 3 June 1969

(31) Convention Application No. 733 824 (32) Filed 3 June 1968 in

(33) United States of America (US)

(45) Complete Specification published 7 June 1972

(51) International Classification C07C 87/30; A01N 9/20

(52) Index at acceptance
C2C 20Y 290 29Y 30Y 32Y 608 630 772 773 791 79Y NW
A5E 1A3B 1A3F 1A3G 1A5A1 1A5B3 1C15D2 1C15F2
1C9A

(54) HEXANE-1,6-DIAMINE DERIVATIVES AND THEIR USE AS FUNGICIDES AND HERBICIDES

(71) We, E. R. SQUIBB & SONS INC. a Corporation organized under the laws of the State of Delaware, United States of America,, of 909 Third Avenue, New York, New York 10022, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to novel hexamethylenebis(alkyldimethylammonium)bromides and their use as foliage fungicides and aquatic herbicides.

The compounds of this invention may be prepared by the reaction of bis - 1,6 - (N-dimethylamino)hexane with the appropriate alkyl bromine in a solution in a suitable solvent, such as acetone. The reaction takes place at elevated temperatures over a period of 6 to 10 hours.

Representative of the alkyl bromides which may be employed in the preparation of the compounds of this invention are: *n*-octyl bromide, *n*-nonyl bromide, *n*-decyl bromide, *n*-undecyl bromide, and *n*-dodecyl bromide.

The compounds of this invention are useful as foliage fungicides, being active against such common fungi as *Monilinia fructicola* and *Alternaria solani*. For such use they would normally be applied at a rate of from 1 to 50 pounds of the active ingredient per acre, although higher rates of application are within contemplation. Actual dosage to be employed depends on the particular active ingredient, components of the formulation, method of application, type and severity of the fungus infestation, duration of treatment, climatic conditions, and the like.

The compounds of this invention find further utility as aquatic herbicides. To control aquatic weeds, the compounds of this invention are applied to the water in which the weeds are growing, in concentrations of from 0.001 to 10 parts per million, preferably from 0.001 to 2 parts per million of water.

Included among the aquatic plant pests which are conveniently controlled in accordance with this invention are: submerged plants such as bladderwort (*Utricularia sp.*), bushy pondweed (*Najas sp.*), coontail (*Ceratophyllum sp.*), elodea, fanwort (*Cabomba sp.*), pondweeds (*Potamogenton sp.*), water milfoil (*Myriophyllum sp.*), waterweed (*Anacharis Elodea sp.*), water star grass (*Heteranthera sp.*), and wild celery (*Vallisneria sp.*), floating weeds such as duckweed (*Lemna*), floating fern (*Ceratopteris sp.*), waterfern (*Salvinia sp.*), water hyacinth (*Eichhornia sp.*), water lettuce (*Pistia sp.*) and water meal (*Wolffia*), rooted plants with floating leaves such as water lilies (*Nuphar sp., Nymphaea sp.*) and lotus (*Nelumbo sp.*), emersed plants such as alligatorweed (*Alternanthera*), arrowhead (*Sagittaria*), bullrush (*Scirpus sp.*), cattails (*Typha sp.*), lizardtail (*Saururus*), rush (*Juncus sp.*), parrotfeather (*Myriophyllum*), water pennywort (*Hydrocotyle sp.*), pickerelweed (*Pontederia*), sawgrass (*Cladium*), smartweed (*Polygonium sp.*), spikerush (*Eleocharis sp.*), water leaf (*Hydrolea sp.*), water primrose (*Jussiaea sp.*), cut-grass (*Zizaniopsis*), black willow (*Salix sp.*), buttonbush (*Cephalanthus sp.*) and ditchbank grasses such as southern cutgrass (*Leersia*), floating-grass (*Paspalum*), jaragua (*Hyparrhenia*), knotgrass (*Paspalum*), maidencane (*Panicum*), common reeds and watergrass (*Hydrochloa*). The foregoing list is by way of example only is is not intended to limit the scope of the invention.

An important advantage to the use of the compounds of this invention is selectivity. Although these compounds exhibit very good herbicidal effect upon aquatic weeds, they have little or no effect upon the usual broadleaf varieties of weeds found on land and, in addition, may be employed at high rates of application for the control of disease in farm crops without fear of injury to the seeded crop itself.

In use these compounds are applied in any of a variety of formulations. Preferably the com-

[*Price 25p*]

pounds are extended with carriers or conditioning agents of the kind used and commonly referred to in the art as adjuvants or modifiers. Such adjuvants may be inert solids, surface-active agents and/or organic liquids.

The compounds of this invention are incorporated in such compositions in sufficient amount to exert a herbicidal effect. Usually from 1 to 95 percent by weight of the compounds are included in such formulation.

Solid formulations may be prepared with inert powders. The formulations thus prepared are used as such, diluted further with inert solids to form dusts, or suspended in a suitable liquid medium for spray application.

The powders usually comprise the active ingredient admixed with minor amounts of conditioning agents. Neutral clays, for example, the absorptive attapulgite or the relatively non-absorptive china clays, diatomaceous earth, walnut shell flour, redwood flour, synthetic fine silica, calcium silicate and other inert solid carriers of the kind conventionally employed in powder formulations are used.

The active ingredient is suitably from 1 to 95 percent by weight of the compositions. The solids preferably are finely divided and have a particle size below 50 microns or, better, below 20 microns. Dust formulations are prepared using talc, pyrophyllite, tobacco dust, volcanic ash or other dense, inert solids as diluents.

Liquid compositions are prepared by mixing the active compound with suitable liquid diluent media. The active compound is either in solution or in suspension in the liquid medium. Suitable liquid media include kerosene, Stoddard solvent, xylene, alcohols, alkylated naphthalenes, diesel oil, glycols, and ketones, for example, diisobutyl ketone and cyclohexanone. The active ingredient is preferably from 0.5 to 50 percent by weight of these liquid compositions. These compositions are used as such or extended by emulsification with water.

The wettable powders or liquids of this invention suitably include one or more surface-active agents, for example, wetting, dispersing, or emulsifying agents. Compositions containing these surface-active agents disperse or emulsify easily in water to form aqueous sprays. The compositions suitably contain up to 10 percent by weight of the surface-active agents, but some surface-active agents are effective at less than 1 percent.

Surface-active agents are suitably of the anionic, cationic, or nonionic type. Exemplary of such agents are sodium oleate, sulfonated petroleum oils, alkyl aryl sulfonates, sodium lauryl sulfate, polyethylene oxides, lignin sulfonates, and the like. Additional suitable agents are described by McCutcheon in "Soap and Chemical Specialties," Volume 31, Nos. 7—10 (1955).

In the case of aquatic weeds, periodic treatments may be required for effective control in flowing water. In the case of rooted aquatic plants, it is often desirable to employ the active ingredients in a heavy vehicle such as a granule (e.g., attapulgite clay granules) which will carry it to the stream bed, and which will resist movement by the currents, thus increasing the length of time that the herbicide remains in the vicinity of the weed roots.

On the other hand, to control plants characterized by substantial foliage floating on top of the water (e.g., duckweed, floating fern, water hyacinth, water lettuce, and so forth), this active ingredient is more advantageously applied with a carrier lighter than water, such as wood shavings, ground corn cobs or organic emulsions, particularly inverse emulsions. This results in the herbicide being entrapped in the foliage as it floats downstream and thus provides convenient exposure of the foliage to a high concentration of the herbicide.

The following examples are representative of the invention, although not necessarily limiting its scope. All temperatures are in degrees Centrigrade unless stated otherwise.

Example 1

Hexamethylenebis - (*n* - decyl - dimethylammonium)dibromide

Twenty g. bis - 1,6 - (N - dimethylamino)-hexane, 52 g. n-decyl bromide, and 200 ml. acetone are mixed in a pressure bottle and allowed to stand in a water bath at 45° for eight hours. A white crystalline material precipitates. It is filtered off and recrystallized from 100 ml. dried and distilled isopropanol and 200 ml. anhydrous ether to give 48 g. (68 percent yield) of product, m.p. 217—218°.

Example 2

Hexamethylenebis - (n - dodecyldimethylammonium)dibromide

17.5 g. Bis - 1,6 - (N - dimethylamino)hexane and 50 g. lauryl bromide are mixed with 400 ml. acetone in a pressure bottle and heated at 45° for eight hours. The product is filtered off and recrystallized twice from isopropanol and ether to give 39 g. (58 percent yield) of product, m.p. 225—226°.

In a like manner, by substituting the appropriate alkyl bromide for the n-decyl bromide of Example 1, there are obtained the following products:

Example	Reactant	Product
3	*n*-octyl bromide	hexamethylenebis-(*n*-octyldimethyl-ammonium)dibromide
4	*n*-nonyl bromide	hexamethylenebis-(*n*-nonyldimethyl-ammonium)dibromide
5	*n*-undecyl bromide	hexamethylenebis-(*n*-undecyldimethyl-ammonium)dibromide

EXAMPLE 6

As a foliage fungicide, compounds of this invention were tested by the standard slide germination procedure of the Phytopathological Society (PHYTOPATHOLOGY, 33: 627—632, 1943). The products of Examples 1 and 2, tested by this procedure at a concentration of 25 parts per million, each produced 100 percent inhibition of spore germination of *Monilinia fructicola*.

EXAMPLE 7

Further evaluation for the control of foliage disease was conducted by the method of McCallan *et al.* ("A Greenhouse Method of Evaluating Fungicides by Means of Tomato Foliage Diseases," contrib. Boyce Thompson Inst. 13; 93—134, 1943). Tomato plants were sprayed with a series of concentrations of the chemical in distilled water. After the spray dried, the plants were inoculated with spores of *Alternaria solani* and held at conditions favorable for disease to develop. The number of disease lesions on the leaves was counted and compared with the number developing on the untreated control plants. The ratio of these two numbers is expressed as percent disease reduction. The products of Examples 1 and 2, tested by the procedure at a concentration of 25 parts per million, each produced 100 percent disease reduction.

EXAMPLE 8

Aquatic herbicidal activity was determined in the following manner. Both duckweed and an algae mixture were grown in Hillman's medium which contains:

	mg./l.
KNO_3	1515
$Ca(NO_3)_2 \cdot 4H_2O$	1180
KH_2PO_4	680
$MgSO_4 \cdot 7H_2O$	492
H_3BO_3	2.86
$ZnSO_4 \cdot 7H_2O$	0.22
$Na_2MoO_4 \cdot 2H_2O$	0.12
$CuSO_4 \cdot 5H_2O$	0.08
$MnCl_2 \cdot 4H_2O$	3.62
$FeCl_3 \cdot 6H_2O$	5.40
Tartaric acid	3.0

The test compounds were then added to half of the tubes. Fronds of duckweed were added to several tubes and mixed algae were added to several others, half containing the test compounds and half not. The inoculated tubes were placed on slanting boards in a 75° F. constant temperature room which was illuminated fourteen hours per day. After ten days incubation, the treated and control tubes were compared. In the control tubes a tenfold increase in frond numbers of duckweed was observed. A corresponding increase in the growth of mixed algae was also noted. In this test at a concentration of ten parts per million, both hexamethylenebis(n - decyldimethylammonium)dibromide and hexamethylenebis(n - dodecyldimethylammonium)dibromide gave 100 percent control of mixed algae and 85 percent control of the duckweed.

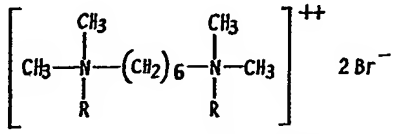
EXAMPLE 9

The compounds of Examples 1 and 2 were applied to five aquatic plants (*Pithophora, Najas, Potamogeton,* Water Star-Grass and *Elodea*) as a dilute aqueous solution in a concentration of 10 parts per million by weight. Four-to six-inch cuttings of each aquatic plant were placed in a one-gallon glass jar with dechlorinated tap water. The jars were tightly covered to prevent evaporation and contamination of the water. The planted jars were illuminated by cool, white, thin-line fluorescent lamps. The intensity of the illumination of the water surface was from 60- to 100-foot candles. The plants were illuminated for 10 hours each day from 8 a.m. to 6 p.m. They were allowed to remain in the jars for a condiitoning period of three weeks, during which time fertilizer was periodically added to the jars. At the end of this time the jars were checked to be sure that the plants were vigorously growing. Any jars with discolored or dead plants was discarded from further use. An aqueous solution containing 10 parts per million of the test compound was then added to the jars and the jars immediately tightly sealed. The jars were then maintained under the same conditions for an additional three weeks as during the three-week conditioning period. At the end of the

test period, the effects of the test compounds were evaluated. Evaluation of herbicidal effects for each chemical on each species of plant was by visual observation, with injury to the plant rated on a scale of 1 (no visible injury) to 10 (a dead plant). Ratings from 1 to 3 indicate no, or very slight, herbicidal activity, from 4 to 6 indicate moderate herbicidal activity, and from 7 to 9 indicate definite to severe herbicidal activity. Independent ratings were made on each species of plant. These ratings were then averaged for each of three replications and these results again averaged to determine an overall average effect expressed as percent herbicidal effectiveness. In this test both hexamethylenebis-(n - decyldimethylammonium)bromide and hexamethylenebis - (n - dodecyldimethylammonium)bromide exhibited an average overall effectiveness of over 90 percent. In no case did any rating fall below 7.

WHAT WE CLAIM IS:—

1. A compound having the formula



wherein R is an alkyl radical containing from 8 to 12 carbon atoms.

2. A compound as claimed in claim 1 wherein R is *n*-octyl, *n*-nonyl, *n*-decyl, *n*-undecyl or *n*-dodecyl.

3. A compound as claimed in claim 1 wherein R is *n*-decyl.

4. A compound as claimed in claim 1 wherein R is *n*-dodecyl.

5. A compound as claimed in claim 1 substantially as herein described.

6. A method of controlling fungi which comprises contacting such fungi with a fungicidal amount of a compound as claimed in any of the preceding claims.

7. A method as claimed in claim 6 wherein R is *n*-decyl or *n*-dodecyl.

8. A method of controlling aquatic weeds which comprises contacting such weeds with a herbicidal amount of a compound as claimed in any of claims 1 to 5.

9. A method as claimed in claim 8 wherein R is *n*-decyl or *n*-dodecyl.

10. A method of controlling fungi as claimed in claim 6 and substantially as herein described.

11. A method of controlling aquatic weeds as claimed in claim 8 and substantially as herein described.

12. Foliage which has been treated for controlling the growth of fungi thereon by a method as claimed in any of claims 6, 7 and 10.

Agents for the Applicants
STANLEY POPPLEWELL, FRANCIS & ROSS
Chartered Patent Agents
Cursitor House,
9—11 Cursitor Street,
London, E.C.4.

Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1972.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.